SCIENCE

NEW SERIES
VOL. LIV, No. 1409

FRIDAY, DECEMBER 30, 1921

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $6.00

SCIENCE

FRIDAY, DECEMBER 30, 1921.

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

(a) ON SOME PRESIDENTIAL ADDRESSES: (b) THE WAR AGAINST THE INSECTS[1]

To prepare a presidential address to be delivered before either the British or the American Association for the Advancement of Science is a very serious matter, and many eminent men have found it so. Is it not a sad thought that each year for many years there has been a man here and one over there who has had to worry for months, first as to his subject and again as to its mode of presentation? Of course, it sometimes happens that a man like Mr. Balfour over there or Dr. Eliot on this side is made president, and of course such men can write profound and charming addresses almost in their sleep, they have become so accustomed to formal functions of great importance. But the average man of science, even of presidential caliber, is a specialist, absorbed in his work, and the sudden realization that he must prepare an address which should interest all scientific men and should help to interest others in science is appalling.

I imagine that few of you have ever thought of this psychological aspect of presidential addresses. Possibly many of you never took the trouble to read a presidential address. Presidential addresses are things one is rather inclined to take for granted, and when one turns the pages of the journal *Nature* or the journal *Science* one is apt to say to oneself " That looks good; some day I must read it "; and then, after a glance at the news notes, the journal goes on file. In other words, presidential addresses demand the serious attention of the men who prepare them and of very few besides. Yet, I have never heard a presidential address before either the British Association or

[1] Address of the President of the American Association for the Advancement of Science, Toronto, 1921.

the American Association that did not deserve serious reading and study.

For twenty-three years, year after year, I have sat on the platform near the president of the American Association for the Advancement of Science during the delivery of his address, until I may justly claim to be an expert on presidential addresses, in much the same way that the leader of a hotel-orchestra can claim to be an expert on after-dinner speeches—because he has heard so many!

At all events, the twenty-two and more addresses of this character which I have heard, and the one hundred others which I have read, have given me the idea that it would not be amiss to deliver a presidential address on the subject of presidential addresses. I have been rather pleased with this idea, and will in fact elaborate it before I take my seat.

But there are other ideas that have been almost equally insistent and which fit rather more closely to the average notion of propriety for so important an address as this theoretically should be. One of them is a consideration of what seem to me to be educational fallacies in the teaching of science to-day, and especially of the biological sciences. But I am modest, and I am ignorant. I have never been a teacher, and, in order to discuss this vital question in any but a perfectly one-sided way, one must know intimately the viewpoint and the ultimate aim of those who control the teaching, especially of the biological sciences, in our great laboratories. I should visit the work shops at Harvard and Yale, at Columbia, at the University of Pennsylvania, at Johns Hopkins, at the University of Chicago, or here, at Toronto, and talk at length with the men in charge; and then I should go to Woods Hole in the summer, where the teachers themselves go to study and to be taught, and should do my utmost to convince myself that they are right in ignoring most practical problems and are justified in spending their lives on the search for fundamental principles and, what is more to the point, teaching little but facts and methods relating to their own studies and to the studies of their school. I have no time for this, and so can not enter fairly into the subject.

As I am writing this (July 29), I see that Sir Edward Thorpe has announced as the subject of his address before the British Association at Edinburgh "The Aspects and Problems of Post-War Science, Pure and Applied." It was the war that helped make me more dissatisfied than ever with the results of biological teaching in America, just as it has been the war that has caused the British people to distrust their whole educational system. With us in Washington, the teachers from the principal universities were brought together, and a National Research Council was formed. The results of the work of this organization in the direction of biology and agriculture, so far as they applied to the prosecution of the war, were largely negative; but that much good will result to the country by the bringing of these men to Washington in the great emergency there can be little doubt, since I have the hope that it opened their eyes to the fact that their university work might have been of much greater value to their country, and to the further fact perhaps that there exist under the federal government agencies which are working upon biological problems effectively and with the highest attention to scientific methods and scientific ideas.

Laying aside then this idea of an educational discussion, the idea that is always with me, of once more considering what Sir Harry Johnston has with his usual felicity called "the next great world war"—the war of humanity against the class *Insecta*—has still further impressed itself upon me. And so there are two topics which I shall briefly discuss—first, presidential addresses, and, second, our struggle against insects.

ON SOME PRESIDENTIAL ADDRESSES

Let us hurriedly glance at the presidential addresses delivered before the British and the American Associations from 1895 down to last year, 1920, and at the men who delivered them. During that period there were 27 such addresses before the American Association and 24 before the British Association, the discrepancy being due to the omission of the 1917 meeting of the

British Association and the holding of two extra meetings by the American Association.

It was formerly the custom in the British Association to review the progress of science each year, and this was usually done in a way in the address of the president. As time went on and science became very intricate and highly specialized in its different parts, the individual, no matter how great his ability and his general knowledge, found himself less and less able to cover the whole field, and so the character of the presidential addresses became diversified. In a measure the same trend has occurred in America. But the British, more conservative than we are over here, or perhaps having the habit of electing broader men to the presidency, have been slower in breaking away from custom, and of their later addresses on the other side seven of the twenty-four have been devoted to a review of the progress of science, while in America only two out of twenty-seven have followed this old and admirable plan. But the diversity in the other addresses has been almost as great with the British as with the Americans. On topics connected with physics, there have been 3 with the British and 3 with the Americans; with anthropology, 2 with the British and 2 with the Americans; in astronomy, 1 with the British and 3 with the Americans; botany, 1 British and 2 American; medical science, 2 British and 2 American; geology, 1 British and 2 American; chemistry, 1 British and 2 American; biology, 2 British and 3 American; economics, 2 American; engineering, 1 British; and the remaining addresses can not be classified.

What a wealth of good things can be found in these addresses! Who can forget Sir Joseph Lister's address on "The Interdependence of Science and the Healing Art" delivered at Liverpool, 1896, and the modest way (characteristic of the man) in which he broke his long silence concerning his own great part in the discoveries that revolutionized the surgical practise of the world? He said,

> Pasteur's labors on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience, but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savor of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practise of my dearly loved profession. And it will perhaps be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Who of us Americans who heard it can forget the address of Sir John Evans at the Toronto meeting in 1897, in which the following words were used,

> Our gathering this year presents a feature of entire novelty and extreme interest, inasmuch as the sister Association of the United States of America —still mourning the loss of her illustrious President, Professor Cope—and some other learned societies, have made special arrangements to allow of their members coming here to join us. I need hardly say how welcome their presence is, nor how gladly we look forward to their taking part in our discussions, and aiding us by interchange of thought. To such a meeting the term "international" seems almost misapplied. It may rather be described as a family gathering, in which our relatives more or less distant in blood, but still intimately connected with us by language, literature, and habits of thought, have spontaneously arranged to take part.
>
> The domain of science is no doubt one in which the various nations of the civilized world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected?

How well the following years have carried forward this idea of Sir John Evans, not only in the domain of science but in the vital affairs of national relations, was amply shown in England's influential moral support of the United

States in the war with Spain, and the response of millions of the American youth to the call from the other side during the terrible years so recently passed, thousands upon thousands of them not waiting for the direct call of their seemingly slow government.

In thinking of those days I love to remember the eloquent words of an Oxford contributor to the *London Times* of April 13, 1917, just before the cream of our youth in rapidly increasing numbers had gone over, thousands to serve with your Canadian troops, and thousands more to help the cause of right in other service.

> It is difficult to judge a whole nation. What is the criterion of judgment, and who are they that are judged? Some of us, and some of our own citizens, have judged America and found her wanting in open-eyed recognition of the issues of this struggle and unflinching determination to face the issues boldly. But if we are to be judged by our statesmen, might we not too deserve the same judgment? The issues were coming, coming, coming for years before this war began. Yet it is not easy to say that our recognition of these issues was open-eyed, and our determination to meet them unflinching. We do not dwell on these things in our past, and why should we dwell on these things and things like these in the history of another nation? If a nation is to be judged, let it be judged by the answer that its spirit makes, in the hour of need, through its purest and most chosen voices—the voice of the young, who are the first to hear and the quickest to obey, the call of Duty and Honor. If that be our criterion, and these are they that are judged, then America may be proud, and may stand secure in the day of judgment. For her young men answered, and answered early, and their answer was "We come."

While there have been two addresses relating to the great war, the one by Sir James Thorpe delivered at Edinburgh last summer, and that read by Van Hise at the Pittsburgh meeting of 1917 entitled "Some Economic Aspects of the World War," the subject of human warfare does not seem to have been mentioned in any of the presidential addresses of earlier years, with one exception: Asaph Hall, the astronomer, in his Washington address in 1903, the title of which was "The Science of Astronomy; Historical Sketch, its Future Development, the Influences of the Sciences on Civilization," used the following words which to-day are of extraordinary significance in view of recent events:

> Men do not change much from generation to generation. Nations that have spent centuries in robbery and pillage retain their disposition and make it necessary for other nations to stand armed. No one knows when a specious plea for extending the area of civilization may be put forth, or when some fanatic may see the hand of God beckoning him to seize a country. The progress of science and invention will render it more difficult for such people to execute their designs. A century hence it may be impossible for brutal power, however rich and great, to destroy a resolute people. It is in this direction that we may look for international harmony and peace, simply because science will make war too dangerous and too costly.

Quite as striking as this, but in another way, was Sir Norman Lockyer's address at Southport in 1903, in which he discussed "The Influence of Brain Power on History." This was mainly a plea for more universities and more research and the need of a scientific national council. Had this strong plea been heeded and acted upon, England would have found herself in much better condition to confront Germany in 1914.

In general these addresses have been extremely serious. Nearly all of the men delivering them have felt that they had an important message to give. All have felt the importance of the occasion and have tried to rise to it. As a result, traces of true humor have been scarce, and it is with a surprised joy that one greets the following paragraph in Farlow's address at New Orleans in 1906. His subject was "The Popular Conception of the Scientific Man at the Present Day," and his address was largely devoted to a discussion of government and university scientific positions. In his introduction he said:

> We are so accustomed to hear reports on the progress of science that we have almost ceased to ask ourselves what we mean by progress. What is or is not progress depends of course upon the point of view. Some are so far ahead of the majority that they can not see how much progress is made by those behind them, others are so far in the rear

that they can not distinguish what is going on ahead of them. We must also admit that there are different directions in which progress may be made. You have all seen the agile crab and been surprised to find how rapidly he gets over the ground, although he never seems to go ahead, but to scramble off sideways. The crab, perhaps, wonders why men are so stupid as to try to move straight forward. It is a popular belief, but, not being a zoologist, I am not prepared to vouch for its correctness, that the squid progresses backward, discharging a large amount of ink. One might perhaps ask: Is the progress of science sometimes like that of the crab, rapid but not straight forward, or, like the squid, may not the emission of a large amount of printer's ink really conceal a backward movement? So far as the accumulation of facts is concerned, there is a steady onward progress in science and it is only in the unwise or premature theorizing on known or supposed facts that science strikes a side track or even progresses backward.

A few Americans were present at the Australasian meeting of the British Association in 1914 and had the pleasure of listening to the remarkable addresses on heredity delivered at Melbourne and Sydney by the distinguished guest of the American Association at this present meeting, Prof. William Bateson. These lectures, for general and vital interest, are almost unsurpassed in the long list of presidential addresses delivered before the one or the other of the two great associations. Only a few of us heard them; many of us have read them; and it is a joy to know that we are to listen to Professor Bateson to-morrow night.

Several of the retiring presidents in both associations have ventured into the domain of prophecy. Even now the address of Sir William Crookes at Bristol in 1898 is remembered. His startling display and discussion of the decreasing wheat supply of the world and the necessity of securing nitrogen from the air created an enormous amount of interest. Ten years later, Nichols at Baltimore, in his discussion of "Science and the Practical Problems of the Future," referring to the exhaustion of our supply of fixed nitrogen, the contingency discussed by Sir William Crookes in 1898, and to the exhaustion of our free oxygen more recently discussed by Lord Kelvin, concluded that these problems were still so remote as to have no immediate practical importance; but his address was written at a time when the conservation movement was just beginning in this country although it had already gained much force, and he referred especially to the coming exhaustion of coal, wood, ores and soils. His address was a tremendous plea for intensive research, and included the significant sentence, "We need not merely research in the universities, but universities for research." One of his final sentences reads, "Beyond lies that future in which it will no longer be a question of supremacy among nations, but of whether the race is to maintain its foothold on the earth."

The very following year, Chamberlin at Boston, in making "A Geologic Forecast of the Future of our Race," concluded with a more hopeful outlook and sent his audience home in a much happier frame of mind. He said:

> While, therefore, there is to be, with little doubt, an end to the earth as a planet, and while perhaps previous to this end, conditions inhospitable to life may be reached, the forecast of these contingencies places the event in the indeterminate future. The geologic analogies give fair ground for anticipating conditions congenial to life for millions and tens of millions of years to come, not to urge even larger possibilities.

But these fifty-one addresses, as well as those that preceded them, are full of significant and quotable things. We on this side will never forget that remarkably beautiful address of Jordan's in 1910 on "The Making of a Darwin." Those on the other side who heard it will never forget Professor Schaefer's address at Dundee in 1912, on the "Nature, Origin and Maintenance of Life," in which, in closing, he gives a wonderfully eloquent description of natural death—"A simple physiological process as natural as the on-coming of sleep."

This leads us to the side thought, not only of Professor Schaefer's own age at that time (it was sixty-two), but also to the interest attaching to the ages of all of the presidents

of the two associations. It is undoubtedly true that each of these men had achieved unusual prominence in scientific work at the time he became president of the one or the other of the two great associations. An analysis of the careers of each one of them is not possible at the present time, nor is it possible to indicate whether his address was delivered at the crowning period of his productive scientific life. With some of them it was, with others it was not. As a matter of fact, however, the average age of the presidents of the British Association was sixty-one years and eleven months, and with the American Association it was sixty-one years and five months. The youngest president of the British Association during the period under consideration was fifty-three years of age. This held for Professor Rucker, Sir J. J. Thomson, and Professor Bateson. The oldest of them was Professor Bonney, whose address was delivered at the age of seventy-seven. The youngest of the American presidents were Minot and Richards, whose addresses were delivered at the age of fifty; and the oldest was Eliot, whose Philadelphia address was delivered when he was seventy-nine years old. I remember that Dr. Eliot hesitated to accept the presidency on the ground that he might not live another year to deliver his address. That was eight years ago and he is still living and writing at the age of eighty-seven.

One is strongly tempted at this point to enter briefly upon a discussion as to the average length of the productive life of a scientific man and as to the average period of its practical end. But the semi-humorous and totally misunderstood remark by Sir William Osler at his farewell address at Johns Hopkins in 1904 has been so voluminously criticized and has caused so much sorrow, or so much indignation as the case may be, to still productive men away past their early forties, and the side of the veterans has been so triumphantly defended, that further argument and illustration are unnecessary. We may safely assume, in fact, that the usefulness of the man past middle age is granted, and that, while he may not have the illuminative bursts of inventive or speculative genius which come to the younger man, he is better able to make the broad generalizations based upon accumulated experience—in other words, to prepare an appropriate presidential address as president of the British or the American Association for the Advancement of Science!

But so far I have only skirted a promising field. I have an idea that some one should go deeply into the subject, not only of presidential addresses before the British and American Associations, but of all presidential addresses. Why do we have such addresses? If there is a good reason—and there probably is—why do not people read them? Or *does* some one read them? And if so, who? and why? Some presidents prepare addresses which they hope will interest the people who come to listen to them. Others are perfectly indifferent to their listeners, and perfunctorily read addresses intended for later severely restricted groups of readers, such as the professional astronomers of the world, as Harkness did, for example, in 1893 at Madison. A host of ideas occur to me that suggest promising lines of investigation, but I leave their elaboration to some one of my successors who may like the task and who may be a psychologist fitted by training to deal with it.

THE WAR AGAINST THE INSECTS

Count Korzybski, in his recent remarkable book "The Manhood of Humanity," gives a new definition of man, departing from the purely biological concept on the one hand and from the mythological-biological-philosophical idea on the other, and concludes that humanity is set apart from other things that exist on this globe by its *time-binding* faculty, or power or capacity. This is another way of saying that man preserves the history of the race and should be able to profit by a knowledge of the past in order to improve the future. It is indeed this *time-binding* capacity which is the principal asset of humanity, and this alone would make the

human species the dominant type of the vertebrate series. But, biologically speaking, there is another class of animals which, without developing the *time-binding* faculty, has carried the evolution of instinct to an extreme and has in its turn come to be the dominant type of another great series, the Articulates, or the Arthropods. As Bouvier puts it,

> Man occupies the highest point in the vertebrate scale, for he breaks the chain of instincts and assures the complete expansion of his intelligence. The insects hold the same dominating position in the Articulates where they are the crowning point of instinctive life.

Unlike the Echinoderms and the Mollusks which have retained their hard coverings or shells and have therefore progressed more slowly—for, as Bergson says, "The animal which is shut up in a citadel or a coat of mail is condemned to an existence of half sleep"—vertebrates, culminating in man, have acquired the bodily structure which, with man guided by the equally acquired intelligence, has enabled him to accomplish the marvels which we see in our daily existence. And, too, the Articulates have in the course of the ages been modified and perfected in their structure and in their biology until their many appendages have become perfect tools adapted in the most complete way to the needs of the species; until their power of existing and of multiplying enormously under the most extraordinary variety of conditions, of subsisting successfully upon an extraordinary variety of food, has become so perfected and their instincts have become so developed that the culminating type, the insects, has become the most powerful rival of the culminating vertebrate type, man.

Now, this is not recognized to the full by people in general—it is not realized by the biologists themselves. We appreciate the fact that agriculture suffers enormously, since insects need our farm products and compel us to share with them. We are just beginning to appreciate that directly and indirectly insects cause a tremendous loss of human life through the diseases that they carry. But apart from these two generalizations we do not realize that insects are working against us in a host of ways, sometimes obviously, more often in unseen ways, and that an enormous fight is on our hands.

It will be obvious, I think, that this statement is not overdrawn. Quite recently a better appreciation of the situation is beginning to show itself. Early in the war (July, 1915) Sir Harry Johnston's strong article entitled "The Next War: Man *versus* Insects" was published in *The Nineteenth Century*; and at the close of the war precisely the same title was used by Lieutenant Colonel W. Glen Liston, of the Indian Medical Service, in his address as president of the Medical Research Section of the Indian Science Congress held at Calcutta in January, 1919. On this side, articles by Felt of Albany, Brues of Harvard, and by the present speaker called especial attention to the important part that entomology and entomologists played during the world war, and since that time several energetic newspaper writers have been trying to place the case before the public.

It is difficult to understand the long-time comparative indifference of the human species to the insect danger. A little more than a hundred years ago the popular opinion of entomology and entomologists in England was well expressed by that admirable character, the Rev. William Kirby, in the following words:

> One principal cause of the little attention paid to entomology in this country has doubtless been the ridicule so often thrown upon the science. The botanist, sheltered now by the sanction of fashion, as formerly by the prescriptive union of his study with medicine, may dedicate his hours to mosses and lichens without reproach; but in the minds of most men, the learned as well as the vulgar, the idea of the trifling nature of his pursuit is so strongly associated with that of the diminutive size of its objects, that an *entomologist* is synonymous with everything futile and childish. Now, when so many other roads to fame and distinction are open; when a man has merely to avow himself a botanist, a mineralogist, or a chemist—a student of classical literature or political economy—to ensure attention

and respect, there are evidently no great attractions to lead him to a science which in nine companies out of ten with which he may associate promises to signalize him only as an object of pity or contempt. Even if he had no other aim than self-gratification, yet "the sternest stoic of us all wishes at least for some one to enter into his views and feelings, and confirm him in the opinion which he entertains of himself"; but how can he look for sympathy in a pursuit unknown to the world, except as indicative of littleness of mind?

This popular impression, so well described by Kirby, continued, and jokes, anecdotes, cartoons, novels and dramas perpetuated the old idea. But even during the active lifetime of the speaker there has come a change. Good men, men of sound laboratory training, have found themselves able in increasing numbers, through college and government support, to devote themselves to the study of insect life with the main end in view to control those forms inimical to humanity, and to-day the man in the street realizes neither the number of trained men and institutions engaged in this work nor the breadth and importance of their results not only in the practical affairs of life but in the broad field of biological research. The governments of the different countries are supporting this work in a manner that would have been considered incredible even five and twenty years ago, and this is especially true of the United States and Canada and hardly less so of France and Italy and Japan and South Africa and, at least until four years ago, Russia.

It may be worth while here, however, to point out that certain European countries are combining their studies of agricultural entomology and crop diseases under the term phytopathological studies, or an Epiphyte Service (*Service des Epiphyties*), as in France, and this is unfortunate, since it obscures to a certain extent the great issue of insect warfare and divides the great field of economic entomology in a most unfortunate way. Let us hope that the movement will not grow. Let the entomologists cooperate with the pathologists, both plant and animal, wherever there is something to be gained by such cooperation, but let us keep the respective fields entirely clear.

The war against insects has in fact become a world-wide movement which is rapidly making an impression in many ways. Take the United States, for example, where investigations in this field are for the time being receiving the largest government support. Every state has its corps of expert workers and investigators. The federal government employs a force of four hundred trained men and equips and supports more than eighty field laboratories scattered over the whole country at especially advantageous centers for especial investigations. And there are teachers in the colleges and universities, especially the colleges of agriculture, who are training clever men and clever women in insect biology and morphology and in applied entomology both agricultural and medical.

All this means that we are beginning to realize that insects are our most important rivals in nature and that we are beginning to develop our defense.

While it is true that we are *beginning* this development, it is equally true that we are only at the start. Looking at it in a broad way, we must go deeply into insect physiology and minute anatomy; we must study and secure a most perfect knowledge of all of the infinite varieties of individual development from the germ cell to the adult form; we must study all of the aspects of insect behavior and their responses to all sorts of stimuli—their tropisms of all kinds; we must study the tremendous complex of natural control, involving as it does a consideration of meteorology, climatology, botany, plant physiology, and all the operations of animal and vegetal parasitism as they affect the insecta. We must go down to great big fundamentals.

All this will involve the labors of an army of patient investigators and will occupy very many years—possibly all time to come. But the problem in many of its manifestations is a pressing and immediate one. That is why we are using a chemical means of warfare, by spraying our crops with chemical compounds and fumigating our citrus orchards and mills and warehouses with other chemical compounds, and are developing mechanical means both for utilizing these chemical means and for

independent action. There is much room for investigation here. We have only a few simple and effective insecticides. Among the inorganic compounds, we have the arsenates, the lime and sulphur sprays, and recently the fluorides have been coming in. Of the organic substances, we use such plant material as the poisons of hellebore and larkspur, pyrethrum and nicotine; and the cyanides and the petroleum emulsions are also very extensively used. No really synthetic organic substances have come into use. Here is a great field for future work. Some of the after happenings of the war have been the use of the army flame-throwers against the swarms of locusts in the south of France, the experimental use against insects of certain of the war gases, and the use of the aeroplane in reconnoissance in the course of the pink bollworm work along the Rio Grande, in the location of beetle-damaged timber in the forests of the Northwest, and even in the insecticidal dusting of dense tree growth in Ohio. The chemists and the entomologists, working cooperatively, have many valuable discoveries yet to make, and they will surely come.

All this sort of work goes for immediate relief. Our studies of natural control follow next. It is fortunately true that there are thousands upon thousands of species of insects which live at the expense of those that are inimical to man and which destroy them in vast numbers; in fact, as a distinguished physicist in discussing this topic with me recently said, "If they would quit fighting among themselves, they would overwhelm the whole vertebrate series." This is in fact one of the most important elements in natural control and is being studied in its many phases by a small but earnest group of workers.

So far, while we have done some striking things in our efforts at biological control, by importing from one country into another the natural enemies of an injurious species which had itself been accidentally introduced, and while we have in some cases secured relief by variations in farm practise or in farm management based upon an intimate knowledge of the biology of certain crop pests, we are only touching the border of the possibilities of natural control.

For an understanding of these possibilities, we must await the prosecution of long studies, just as we must await years of progress of those other studies outlined in a previous paragraph. And all of these studies must be carried on by skilled biologists—thousands of them. At present most of the best men are working away in their laboratories practically heedless of the great and inviting lines of study at which I have hinted and heedless of the tremendous necessity for the most intense work by the very best minds on the problem of overcoming and controlling our strongest rivals on this planet.

And this brings me back to the topic which I touched upon in my opening remarks, namely, the teaching of biology in our colleges and universities. You will remember that I thought to avoid a discussion of this subject because I felt that I could not do it justice without more careful investigation and without a clear knowledge of the viewpoints and purposes of the educators. A good many of us have been thinking for a long time that the teaching of zoology and botany and the so-called biology in the principal colleges and universities in the United States and Canada, and in Europe as well, has taken the wrong trend, or that, if not taking the wrong trend, very many of the more important aspects of these subjects are being ignored, and that everything was running in a single direction. I said a good many of us. That means that, when we come to count them up, there really have been a good many, but they have been so greatly in the minority that they have been ignored in the general movement. Here and there a man has spoken out, but all too infrequently. Jordan, in his presidential address before the American Association, was one of these. C. C. Nutting, in two or three papers, has in a forceful and somewhat humorous way pointed out some of the inconsistencies of modern biological training. Edwin Linton, in his strong and fine address at the Baird Memorial meeting in Washing-

ton in 1916, put it forcibly in the following words:

> As I look over the titles of theses for doctorate degrees in biology, however, knowing that they must, in some fashion, reflect the activities of our biological leaders, I am led to wonder if the failure of science to influence legislation in the interests of the people is not to be charged to the propensity on the part of these leaders to shun the practical. Is there a hierarchy in science that frowns upon independence of thought and action in her sanctuary? That can hardly be. Let the heads of departments of biological research in our universities then take heart, and not be afraid to follow the lead of Pasteur, who surely committed no violence upon science by undertaking the solution of practical problems.

In very recent years there has come about a slight change in the attitude of teachers. The great war has brought this about in part, but this is not the only thing that has had an influence; something intangible—something difficult to locate—perhaps it is many sided—perhaps it is many things contributing to one end—something has opened the minds of many single-track men, and there is a gradual tendency towards broadening which is having its influence on college curricula, on the character of the papers read at the recent meetings of the great national societies, and to a slight extent on the subjects chosen for doctorates in biology in the universities. The recent founding of the Ecological Society of America is a strong evidence of the working of a leavening element; and the recent publication of such books as Cockerell's "Zoology," Needham's "General Biology," and Shull, Larue and Ruthven's "Principles of Animal Biology," and others, shows that the teaching mind is broadening.

I have mentioned the theses for doctorates. I have glanced over the titles of such theses, which represent the bulk of the graduate work in biology in American universities, for the past eight years, as published in the lists of the Library of Congress and in the journal SCIENCE. I find that only a very small percentage of this output represents work which can be of the slightest use to humanity in its immediate problems regarding the insect world, and even those which may prove of use bear some evidence that the lines of study had already been adopted by students who used them incidentally to gain their degrees and were not suggested by their teachers as promising lines leading toward some great practical outcome.

How can we present a convincing argument on the necessity for a better rounded study of everything comprehended in the word *biology*! And how can we emphasize the prime importance of devoting our earliest attention to those problems which most immediately concern our well being? This can not be done authoritatively by a single individual. Perhaps a convert from the present religion, say an eminent authority on cell biology, with that enthusiasm characteristic of recent converts, could put the case more forcefully than could a man who has not achieved prominence in the now accepted lines of work. I am praying for such a convert. But much better than this would be a movement participated in by as many individuals as possible, all with the same general idea, each putting forward the views that have come to him in the course of his own restricted lines of study in biology.

Let us summarize. Few people realize the critical situation which exists at the present time. Men and nations have always struggled among themselves. War has seemed to be a necessity growing out of the ambition of the human race. It is too much, perhaps, to hope that the lesson which the world has recently learned in the years 1914 to 1918 will be strong enough to prevent the recurrence of international war; but, at all events, there is a war, not among human beings, but between all humanity and certain forces that are arrayed against it. Man is the dominant type on this terrestrial body; he has overcome most opposing animate forces; he has subdued or turned to his own use nearly all kinds of living creatures. There still remain, however, the bacteria and protozoa that carry disease and the enormous forces of injurious insects which attack him from every point and which constitute to-

day his greatest rivals in the control of nature. They threaten his life daily; they shorten his food supplies, both in his crops while they are growing and in such supplies after they are harvested and stored, in his meat animals, in his comfort, in his clothing, in his habitations, and in countless other ways. In many ways they are better fitted for existence on this earth than he is. They constitute a much older geological type, and it is a type which had persisted for countless years before he made his appearance, and this persistence has been due to characteristics which he does not possess and can not acquire—rapidity of multiplication, power of concealment, a defensive armor, and many other factors contribute to this persistence. With all this in view, it will be necessary for the human species to bring this great group of insects under control, and to do this will demand the services of skilled biologists—thousands of them. We have ignored these creatures to a certain extent on account of their small size, but their small size is one of the great elements of danger, is one of the great elements of success in existence and multiplication.

Let all the departments of biology in all of our universities and colleges consider this plain statement of the situation, and let them begin a concerted movement to train the men who are needed in this defensive and offensive campaign.

In closing, I can not refrain from quoting a remarkable paragraph from Maeterlinck:

> The insect does not belong to our world. The other animals, even the plants, in spite of their mute existence and the great secrets which they nourish, do not seem wholly strangers to us. In spite of all, we feel with them a certain sense of terrestrial fraternity. They surprise us, even make us marvel, but they fail to overthrow our basic concepts. The insect, on the other hand, brings with him something that does not seem to belong to the customs, the morale, the psychology of our globe. One would say that it comes from another planet, more monstrous, more energetic, more insensate, more atrocious, more infernal than ours. . . . It seizes upon life with an authority and a fecundity which nothing equals here below; we can not grasp the idea that it is a thought of that Nature of which we flatter ourselves that we are the favorite children. . . . There is, without doubt, with this amazement and this incomprehension, an I know not what of instinctive and profound inquietude inspired by these creatures, so incomparably better armed, better equipped than ourselves, these compressions of energy and activity which are our most mysterious enemies, our rivals in these latter hours, and perhaps our successors.

L. O. HOWARD

U. S. DEPARTMENT OF AGRICULTURE

ADDRESS AT THE LAYING OF THE CORNER STONE OF THE CHEMICAL LABORATORY OF THE CORNELL UNIVERSITY

THE great chemical laboratory, the cornerstone of which we lay to-day, will not be without its effect upon the life of the university. Its influence may be good or it may be bad. It is sure to be profound.

Chemistry has many aspects. Sordidly treated, as a mere bread and butter subject, it might conceivably tend to degrade our teaching to a low, materialistic level. Idealistically treated, as becomes a great fundamental science, it will promote the noblest purposes in education.

Are we out of touch with life? Chemistry has the most varied and intimate contacts with life of any of the sciences.

Do we wish to inspire, in our teaching, a passion for truth? The pursuit of science is an unending quest for truth.

Are we inclined to shun specialization lest we lose a certain breadth of training for our students? Let us remember that to really know something of any one of the many branches of a science like chemistry one must use several languages, must be something of a mathematician and physicist and must be acquainted with many allied subjects.

There are few things so broad as a "narrow specialty"—if you follow it down to the ends of its wide spreading roots!

As for the training of the imagination and the building of character, is it not inspiring to turn from the pitiful struggles of the human race as depicted in a world's history whose

every page drips with blood and filth, to the contemplation of the intimate structure of God's universe, perfect, complete; equally majestic whether we view it as a whole or in its minutest parts. It is indeed healthful for the imagination and for the character to delve, now and then into those unseen realms of nature through which wanders in speculative mood the spirit of modern science.

All of these things: the keeping in touch with life, the love of truth, the breadth of culture, the training of the imagination, the building of character are pedagogical considerations. But they are so important that the favorable influence of the new laboratory upon them would in itself make that great gift well worth while. Its real purpose, however, is much more momentous.

The new laboratory will be a center of research from the start. Of that we may be sure, knowing who are to occupy it. By its very completeness and adequacy, assured by years of careful and intelligent planning, it will challenge our chemists to redoubled activity. Enthusiasm and the true spirit of investigation are sure to prevail and notable results may be counted upon.

If the chemists and students of chemistry who are to work in this building attain only an average output as measured by the performance of university laboratories in the past, the donor may count on returns from his investment such as no commercial enterprise has ever paid. Nearly every fundamental discovery has originated in the universities and these discoveries have literally transformed the conditions of life upon our planet. In this transformation chemistry has had a great part.

The cost in money of these first essential steps towards progress has been but trifling. The price of a single battleship would build twenty such great laboratories: that of a modern battle fleet, destined to the scrap heap within ten years, would amply endow all the universities in the land.

We can not remind ourselves too often of all this because these basic things which must precede all invention and industrial development are not ushered into the world with acclamation. Yesterday, so to speak, a quiet, shy little man in a university laboratory studied the emission of electrons from a hot body, described the phenomenon, wrote out the equations and went his way. To-day, as a consequence, you or I may speak to a friend in San Francisco. To-morrow, perhaps, we may be able to call up a man in any part of the world *and hear his living voice*: and very, very few will realize that *Richardson* made that miracle possible!

This is but one instance, and not from the domain of chemistry; were I a chemist and did time permit I could doubtless cite a hundred equally striking cases.

It is obviously difficult to estimate just what credit in the development of modern civilization is to be assigned to the workers in pure science but theirs is clearly an essential part. But for the new knowledge furnished by them modern civilization could not have come into being.

It may be thought that this is an evil day in which to boast of the triumphs of our civilization and that it were well if we could return to the primitive conditions of ancient Greece. I prefer, however, to regard the terrible upheaval which the human race has gone through as a violent attack of indigestion, due to having taken too rapidly into an unaccustomed system the rich new diet proffered by science. Let us hope for the ultimate recovery of the patient.

Measured according to that ultimate standard, which does not fluctuate with the abundance or scarcity of gold, *i.e.*, the happiness of the human race, I believe that the research man, academic trifler, theorist, dreamer, dabbler in things trivial as he seems to the man of affairs, will be found, like that other idle ne'er-do-well, the artist, to be among the most supremely productive of all the world's workers.

Speaking more intimately and personally, we may expect that the renewed activity of our chemists will react upon other departments. There will be joint projects for carrying on extended researches made possible by the new equipment. Thus we may soon hope

to enter upon what is perhaps the most promising next step in the development of the sciences: namely cooperative undertakings on a large scale involving chemistry-physics, chemistry-engineering, chemistry-geology, chemistry-biology, and the like. Many of the pressing problems of the immediate future are too large for any individual or for any single department. In this way, on its scientific side, the university may best serve the community. Thus it may better perform the prime function of every true university—the *advancement of knowledge*.

EDWARD L. NICHOLS

CORNELL UNIVERSITY

THE ORIGIN OF SOIL COLLOIDS AND THE REASON FOR THE EXISTENCE OF THIS STATE OF MATTERS

IN the mechanical analysis of hundreds of samples of soil by the beaker method, the microscopical control of the subsidence of the clay group indicated that the smallest diameter of a clay particle is about 0.0001 mm. while the water from which the sediment subsided was clear and transparent.

At first thought it would appear that in a soil which has weathered under many agencies, such as the grinding of glacial ice, the abrasion of flood waters, the pounding of ocean waves, and other agencies of attrition due to soil movements operating through untold ages, material of every degree of fineness would accumulate, passing down below the limit of microscopic vision. Practically however this does not appear to be the case as the finest material of the soil, called the clay group, excluding the colloidal material, to be discussed later, ranges in diameter from .005 to .0001 mm. The question naturally arises as to what has become of the material of smaller size.

My present view is that particles of matter derived from silicate rocks and other soil-forming minerals when they approach a diameter of .0001 mm. contain relatively so few molecules that the bombardment of the water molecules in which the particle is immersed shatters the particle beyond the ability of the molecules in the solid to hold together as a solid mass. The atoms of calcium, magnesium, potassium and sodium in the molecule of the silicate would go for the most part into true solution, while the atoms of silicon, aluminum, and iron would go chiefly into colloidal solution forming the basis of the colloidal matter or the ultra clay of the soil. It should be possible for the mathematical physical chemist, from physical constants now known, to determine empirically the relative size of the particle of matter which could withstand such bombardment without complete disintegration. This is a problem which has not yet been worked out.[1]

There appears to be a certain equilibrium established between the colloidal state and the truly soluble state as there is always a small proportion of silicon, aluminum, and iron which seem to be in real solution, as they pass through a Pasteur-Chamberland filter and separate out on evaporating the solution not as a colloid but as an amorphous mass of hard scale-like material, like a boiler scale, without absorptive properties.

It is that portion of the silicon, aluminum, and iron which collects on the outside of the Pasteur-Chamberland filter in a truly colloidal condition which is recognized as the ultra clay.

This colloidal matter is very absorptive and takes into itself a considerable quantity of salts of calcium, magnesium, potassium, and

[1] Another way of looking at this is from the point of view of the internal energy of the system. The molecular attraction between the molecules of the solid and the molecular attraction between water molecules themselves and between the molecules of the solid and of the water must come to equilibrium. If the solid particle becomes relatively small in diameter there will be relatively few molecules in the solid to hold together against the attraction of the increasing number of water molecules surrounding them as the size of the solid particle diminishes. The attraction of water molecules for solids which it wets, as, for instance, glass, is seen in the relatively high temperatures and therefore high energies required to remove the *last traces* of water from the solid.

sodium which were in free solution but which are changed in the absorbing medium to a colloidal state in which they are extremely inactive and in which state they fail to respond to reagents that would normally reveal their presence. It is a matter of very great difficulty, therefore, to determine whether the electrolytes found in the ultimate analysis of the ultra-clay are constitutionally combined with the silicate of alumina and iron, or whether they merely exist in a passive colloidal state.

THE TRUE SOLUTION

The study of ultra clay includes fundamental problems of physical chemistry, particularly the differences in state between true solutions and colloidal solutions. The modern concept of solutions ascribes a rather complex form to the molecule of water. The molecule of a salt dissolved in water forms numerous and indefinite hydrates with the surrounding water molecules. The complexity of these hydrates is influenced by concentration and by temperature, or in other words by the balance in the internal energy of the system expressed by the activities of the water molecules on the one hand and the activities of the salt molecules on the other, as well as the activity or energy exerted between the water molecules and the salt molecules.

Little is known about the complexity of the hydrates in the solution. We have actual data only when certain salts crystallize from the solution. With salts that crystallize with water of hydration the lowest hydrates are formed at the higher temperatures and the higher hydrates are formed at the lower temperatures. Magnesium chloride is known to crystallize with five different amounts of water, namely, 2, 4, 6, 8, and 12 H_2O. The higher hydrate (12 H_2O) separates at temperatures between 16.8° to —33.6° C. The lowest hydrate comes out at 181.5° C.

Sodium carbonate is known with three states of hydration, namely, 1, 7, and 10 H_2O, depending upon the temperature. If intermediate hydrates occur they do not appear to be stable forms. It would appear therefore that 12 H_2O is the highest stable hydrate formed in crystals except for the double molecules of the alums which carry twice this amount or 24 H_2O. Sodium chloride crystallizes out at ordinary temperatures without water of hydration, the crystal being completely dry on the inside. It is said to crystallize with 2 H_2O at temperatures somewhat below zero. Sodium sulphate crystallizing at room temperature immediately changes under the same temperature conditions to the anhydrous form when the solution becomes saturated with sodium chloride. This gives us a vision of only a few proportions of water which fit into the molecular structure of the crystal in permanent form. It throws no other light upon proportions of water of hydration which may occur in solution which would not fit into the structure of a crystal in stable form.

The strength of these hydrates differs markedly. Sodium carbonate with 10 H_2O on exposure to air is reduced to sodium carbonate with 1 H_2O. Sodium sulphate with 10 H_2O gives off free water under pressure as when pestled. Any of the three known hydrates of calcium chloride, namely, 2, 4, 6 H_2O, absorbs water when exposed to ordinary air, which changes from a gaseous to a liquid state in which the calcium chloride finally dissolves.

It appears therefore that the water of hydration is influenced by the internal energy of the system and may be modified by the external pressure of the water vapor in the air and by mechanical force.

There are of course numerous cases where salts crystallize without water of hydration or where they come down in the form of amorphous material without crystalline form. There are likewise numerous cases where it is difficult to secure crystals and often impossible to separate material in a solid state which ordinarily comes out in a solid form. The difficulties in obtaining sugar in a solid form with certain impurities, particularly glucose and potassium, or iron, is a case in point. The impossibility of obtaining ortho-

phosphoric acid in a solid state from solutions containing certain impurities is another case in point.

Many of the salts which contain water of crystallization, especially the sulphate carbonate, and acetate of sodium, are remarkable for the fact that when solutions are prepared free from dust and under perfectly quiescent conditions they refuse to crystallize far below their ordinary point of saturation unless they are disturbed by agitation, by particles of dust or particularly by introduction of crystals of the material, when they suddenly crystallize throughout the entire mass. Jeannel years ago stated that he assumes "that saturated solutions when heated form peculiar hydrates and that these remain unaltered when the temperature is lowered but that vibration or the presence of a crystal of the salt is sufficient to bring about their decomposition."

It has been observed by Ostwald that previous to the formation of sodium chloride crystals points of congestion may be noted where droplets form and can be seen under the ultra microscope. This is analogous to the suspensoid form of droplet of a colloidal body, but while the colloidal droplet is stopped from going further the sodium chloride droplet completes its course by coming together into a crystalline mass with the complete exclusion of the water of hydration which has surrounded the molecule in its solution state. Under conditions of supersaturation above referred to it is supposed that these centers of congestion are avoided and crystallization does not occur until by agitation or the introduction of nuclei such centers of congestion are brought about.

COLLOID SOLUTIONS

It would appear that the colloidal state of the silicon, aluminum, and iron is such, the hydrates formed with the water molecules are so complex and the internal energy of the system is so low that the molecules of silicon, aluminum, and iron, and the same would probably be true for colloidal platinum, gold and silver, are unable at ordinary temperatures to combine as a crystalline or amorphous mass. If the temperature is raised to 900 or 1000° the last traces of water disappear, they lose completely their colloidal properties and take on the form of an amorphous mass.

The modern concept of the atom shows a central nucleus charged with positive electricity surrounded by many electrons with negative charges. If the two forces are perfectly balanced the material is inert as in the case of nitrogen gas. The activity of the atoms of other elements depends upon the extent to which this balance is thrown off to one side or the other.

From the modern concept of solutions it would appear that the silicon, aluminum and iron are completely dissociated in their colloidal solution but the positive and the negative portions of the molecules are so balanced that they are in an extremely inactive condition and substances absorbed by them become equally inert and inactive for the same cause and thus change their state from a condition of true solution to a colloidal solution.

The principles of dyeing appear to be based upon a similar change of state. The dye in true solution enters a colloidal membrane such as silk or wool, is changed to a colloidal state in and on the membrane from which it can not thereafter be dislodged with water as the colloidal solution is immiscible with water. The principles of dyeing seem to rest upon the ability of certain materials including mordants which are of such conditions that they have the power to bring about this change of state.

The colloidal material separated from soils in a dilution not exceeding one gram per liter after thorough agitation appears under the ultra microscope as minute droplets showing points of congestion such as precede the formation of salt crystals and appear as droplets of fat suspended in milk or as fog appears in the cloud. In larger concentrations these droplets coalesce into larger masses as the fat globules coalesce on rising into cream or as the droplets of fog coalesce to form the liquid water of larger drops. Fog follows neither the laws of gases nor the laws of liquids. The soil colloid

in suspension in water may be coalesced by salt or lime solutions but the change is not sufficient to overcome the colloidal state as in the case of the coalescence of the fog particles into liquid water, and on removing the coagulating agency the colloidal matter may again be put in suspension.

As before stated the only means yet discovered to change the colloidal nature of the soil colloids is through an enormous expenditure of energy in heating the material to 900° or 1000° to completely drive off the water of hydration and leave the material an amorphous mass lacking entirely colloidal properties. This is too expensive a method to be used in agriculture or in road construction to particularly affect the plasticity of the wet clays. The problem before the soil chemist and the road engineer is to bring about a change in the internal energy of the soil colloid so as to break up the complex hydrates and permit the atoms or molecules of silicon, aluminum, and iron to form a crystalline or an amorphous solid and thus make the extremely plastic clays less plastic and more friable.

The molecular weights of colloids determined from diffusion or from freezing point are very high, reaching the figure 25,000 for starch. The question arises as to whether this figure is applicable to the molecule of the anhydrous colloid or to the colloidal molecule associated with the extremely complex system of hydrates that have attached themselves to the molecule of the colloidal substance. Numerous cases have been reported where zeolites have formed after the percolation of soil moisture through exceedingly small openings in rocks and building stones. The question arises as to whether sufficient force can be exerted to force a colloidal solution through openings too small to carry the associated water of hydration, and whether under these conditions, like the stirring of a supersaturated solution, the molecules of the colloid could be brought sufficiently close to combine into a crystalline or amorphous solid.

This is of theoretical interest only. The practical problem seems to be to find some cheap method of breaking up the complex hydrates to give the atoms of silicon, aluminum and iron, or the hydrated molecules of the silicate an opportunity to combine in a solid form.

Milton Whitney

Bureau of Soils,
Department of Agriculture

WHEN WILL THE TEACHING OF CHEMISTRY BECOME A SCIENCE?[1]

When will the teaching of chemistry become a science? Before answering this question, let us ask another question. When did chemistry become a science? Chemistry became a science when men found that there were different elements; that these elements had different properties; that they could be changed into different forms; that they would react with one another and give different products and that in all these interactions and transformations there was no loss or gain of mass. These are a few of the fundamental conceptions that were necessary before chemistry could become a science.

The teaching of chemistry will become a science when we as teachers recognize that every student is possessed with certain original tendencies with which we are to work just as the chemist works with the elements. These original tendencies are subject to transformations and interactions, but they can not be destroyed any more than an element. The law of the conservation of mass holds. Sometimes the psychologist speaks of an original tendency being eliminated. He means by this that the tendency has been so modified that you can not recognize it. The chemist would say that it had suffered a chemical change or had been changed into an allotropic form.

For the benefit of those people who studied psychology some years ago, I might say that a few of these original tendencies are curiosity, manipulation, mastery, fear, sex instinct, hoarding, ownership, etc. These are the rocks upon which we build our chemical

[1] Read before the Section of Chemical Education, American Chemical Society, New York, September 8, 1921.

structure, and hence in our teaching of chemistry, we must hew these rocks into shape by the use of chemical tools. You may ask what do you mean by this and how may it be done? To illustrate, I will take the first tendency which I mentioned, namely, curiosity.

There is not a normal boy or girl who has not an original tendency to want to know the reason or wherefore of almost everything with which they come in contact. As they begin their school days this tendency is gradually transformed into a submissive tendency by the teacher's desire to not wish to be bothered with so many questions, and when the student reaches the chemistry department, we generally put the finished transformation touch to it, and hence we have destroyed the properties of one of the most energizing elements in the promotion of chemical education.

If we find that a student, when he comes to our chemistry department, has had this tendency partly transformed, it should be our business as teachers of chemistry to bring back or revert this original tendency to its pure condition. Now, you ask me how this may be done. I can tell you how it can not be done. It will never be done by telling the student all the results or letting him read all the results before he goes to the laboratory, that is, by letting him go to the laboratory with the feeling that his experiments are only to illustrate the lecture or book. Such work is highly artificial and not only dulls the keen observations of the student, but absolutely tends to kill all curiosity. To be sure life is too short to find out everything in the laboratory, but what he can find out and has time to find out let him find out without telling him. What he does not have time to find out or can not find out, tell him in plain English. A few things found out for himself will stimulate and augment his curiosity, and put him in an appreciative attitude for results told him. Hence I say that we as chemists can develop this original tendency of curiosity by the proper handling of the laboratory end of chemistry. This must be put up in such a way as to arouse the student's curiosity. This may be done by putting all laboratory work in problem form and letting that problem be one that has not been explained over and over and over again in both lecture and book. You may call this a project in spite of the fact that we understand that a project is a piece of work carried out in its natural setting. The laboratory is a natural setting in the study of chemistry.

I feel that the project or problem method produces the most favorable conditions or situations for arousing and holding the original tendency of curiosity, and furthermore I am sure that this same feeling is shared by many others, and because of this fact I can not understand why it is not more generally used.

I am of the opinion that the entire chemistry course can be developed by the project method. Let the reading matter raise a problem or project, and then let this project be straightened out by a little elementary research. When he has solved his problem or project his book reads smoothly, and when he has solved all the projects in the book his book is complete, and it is not complete until he has. He must do his share before he can gain a full knowledge of his subject. Such a situation produces a normal curiosity, and at the same time there is a very noticeable improvement in his observations and powers of reasoning, both of which are so essential to a chemist.

The teaching of chemistry will become a science when chemistry teachers begin to seek for the situations or conditions that will properly develop all these original tendencies which are closely allied with chemistry. When, we, as chemists, have found the conditions or situations that produce certain results with the elements of chemistry, what do you do? You publish these results or come to such a meeting as this and give other chemists the benefit of your results. Why should you not do likewise when you have found the proper conditions for the development of these original tendencies?

I have mentioned one situation for the development of curiosity. I hope that next year someone else will give us a better situation for its development, and some other men will give us chemical situations for the development of some other original tendencies. When we get all these situations worked out from a chemical standpoint we can tell what situation to put up to get a certain response from a given original tendency just as the chemist knows that he will get a certain reaction from a given element when he subjects it to a certain situation or condition.

When we all have gone back to the student and begun to develop the teaching of chemistry on original tendencies, the teaching of chemistry will become a science, and nothing will hasten that day more than meeting together in an open forum as we have done this week. It is a pity that the teaching of chemistry is not recognized fully as a profession, but no one is at fault but ourselves. Let us become worthy of the profession by studying the teaching of chemistry in a scientific way, and then people will not hesitate to give the calling of teaching chemistry a proper place and the college professor a living wage.

Neil E. Gordon

University of Maryland,
College Park, Md.

SCIENTIFIC EVENTS

EARL JEROME GRIMES

The executive committee of the Association of Virginia Biologists has adopted the following minute:

The executive committee of the Association of Virginia Biologists has heard with deep regret of the death of Earl Jerome Grimes, associate professor of biology in the College of William and Mary. Less than a month ago he was present in our fall meeting and contributed largely to its success. By his death the College of William and Mary has been deprived of a faithful and inspiring teacher; this association of a valued member and counselor; and the science of botany of a young disciple of great promise. To his family and to his college we wish to express our most heartfelt sympathy in their great loss.

This minute we instruct the secretary to spread on the records of the association, to have published in Science, and to communicate it to Mrs. Grimes and to the faculty of the College of William and Mary.

ELECTRIC POWER MAPS

A map of New York State showing the location of the power stations and electrical transmission lines used by public utility companies has been published by the United States Geological Survey, Department of the Interior. It was originally planned to publish these maps as plates in water-supply papers, which were also to contain tabular information in regard to the equipment of the power stations and the chief characteristics of the transmission lines, but to avoid the expense and delay incident to the publication of such reports the maps will be issued separately and sold. The map of New York State is the first one to be published and may be bought for one dollar from the director of the United States Geological Survey at Washington. The base map used is the Geological Survey's map of the state, 64 inches long and 45 inches wide, scale 1:500,000. The map shows the location of the stations and primary transmission lines and bears a numbered list of the power companies, the numbers corresponding to numbers assigned to the stations on the map. Proof maps were first made and sections of them were sent to the companies for correction or revision. Similar maps of New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, Maine, New Jersey, Pennsylvania, Maryland and Delaware are in course of preparation. These maps will be valuable to those who are studying interconnection of power companies and to those who wish to establish manufacturing plants within reach of electric power—in fact, they will be useful to any one contemplating the use of power in any way.

MEDALS OF THE ROYAL SOCIETY

At the anniversary meeting of the Royal Society on November 30, Professor Sherrington presented the medals (we quote from *Nature*) as follows: The Copley medal to

Sir Joseph Larmor, who has long held a leading position in the British school of mathematical physics. It may fairly be said that his preliminary work was of the utmost value in paving the way to the modern developments of the theory of relativity. A Royal medal to Dr. Frederick Frost Blackman, distinguished for his contributions to plant physiology, and especially to knowledge of the process of photo-synthetic assimilation of carbon dioxide. A Royal medal to Sir Frank Dyson, who has devoted special attention to investigations of the movements and distances of the stars and of the bearing of these upon the structure of the stellar universe. It was mainly to his foresight and organizing ability that we owe the successful observations of the deflection of light by the sun's gravitational field during the eclipse of 1919. The Davy medal to Prof. Phillipe Auguste Guye, in recognition of his work on optically active organic substances, on molecular association, and on atomic weights. The Hughes medal to Prof. Niels Bohr, the author of the conception to which the name "Bohr-atom" has been attached. This conception gave a solution of the long-standing puzzle of the Balmer series of hydrogen, and appears likely to provide a complete explanation of the spectra of the various elements.

SCIENTIFIC NOTES AND NEWS

Dr. L. O. Howard, chief of the Division of Entomology of the U. S. Department of Agriculture, gave at Toronto on the evening of December 27 the address of the retiring president of the American Association for the Advancement of Science, which is printed in the present issue of Science. We hope to print in subsequent issues the addresses of the chairmen of the sections and other addresses and proceedings that are of general interest.

At the last meeting of the Indiana Academy of Science held at Indianapolis, Indiana, Dec. 1 and 2, 1921, the following officers were elected:

President: F. M. Andrews, Indiana University.

Vice-president: C. A. Behrens, Purdue University.

Secretary: W. N. Hess, De Pauw University.

Assistant Secretary: H. T. Dietz, Indianapolis, Indiana.

Treasurer: W. M. Blanchard, De Pauw University.

Editor: F. Payne, Indiana University.

Press Secretary: F. B. Wade, Shortridge High School, Indianapolis, Indiana.

The recent election of the Optical Society of America resulted in the choice of the following officers for terms beginning January 1, 1922:

President (2 year term): Leonard T. Troland, Harvard University.

Vice-president (2 year term): Herbert E. Ives, Western Electric Company, New York.

Secretary (5 year term): Irwin G. Priest, National Bureau of Standards.

Treasurer (5 year term): Adolph Lomb, Bausch and Lomb.

Members of the Executive Council (2 year term): Adelbert Ames, Jr., Dartmouth College, W. E. Forsythe, Nela Research Laboratories, Henry G. Gale, University of Chicago, Ernest Merritt, Cornell University.

The retiring president, Professor J. P. C. Southall and all of the above-named officers are ex-officio members of the Executive Council.

At its 1921 meeting at New Orleans, the American Pharmaceutical Association awarded the 1921–22 grant from the A. Ph. A. Research Fund to Dr. David I. Macht, of the Johns Hopkins University, for pharmacological work on the benzyl compounds found in certain galenicals. The first grant made in 1919 was awarded to Dr. George D. Beal, of the University of Illinois, for work on alkaloidal assays, while the 1920 award was made jointly to Dr. Herber W. Youngken, of the Philadelphia College of Pharmacy and Sciences, for work on aconite varieties and Dr. E. Kremers and Miss Lila Winkelblech, of the school of pharmacy of the University of Wisconsin, for work on derivatives of guaiacol.

R. L. Agassiz, of Boston, was elected president of the Copper and Brass Research As-

sociation, at its first annual meeting held in New York, December 6.

Dr. Walter Lawrence Bierring, Des Moines, Iowa, has been elected an honorary member of the Royal College of Physicians of Edinburgh, "to mark its sense of his distinguished services in connection with reciprocity" between the United States and Great Britain in matters of medical education.

Dr. Niels Bohr (Copenhagen), Dr. Johan Hjort, head of the Norwegian Fisheries, and Professor Paul Langevin (Paris) have been elected honorary members of the Royal Institution.

Dr. B. E. Eldred of New York has recently been awarded the Elliott Cresson gold medal of the Franklin Institute, Philadelphia, for his development of the low-expansion leading-in wire for incandescent electric lamps.

The *Journal* of the Washington Academy of Sciences states that Mr. George M. Rommel, chief of the animal husbandry division of the Bureau of Animal Industry, U. S. Department of Agriculture, has resigned to become editor-in-chief of the American International Publishers, New York City. Mr. Rommel had been with the Department since 1901, and had been chief of his division since its organization in 1910.

Captain Ernest L. Bennett, formerly in command of the battleship *New York*, has been designated by the Navy Department as director of the naval experimental and research laboratory now nearing completion at Belleview, on the Potomac River below Washington.

Dr. George H. Whipple, dean of the University of Rochester Medical School, will deliver the fourth Harvey Society Lecture at the New York Academy of Medicine, on Saturday evening, January 7. His subject will be "Pigment metabolism and regeneration of hemoglobin in the body."

Before a meeting of the Chemical Society of the District of Columbia, at the Cosmos Club in Washington on December 8, Dr. H. V. Moore, chief chemist of the Bureau of Mines, spoke on "Radium," Dr. Howard A. Kelley on "The Therapeutic Use of Radium in the Treatment of Cancer," and Miss Armstrong of the Bureau of Standards on "The Quantitative Measurement of Radium."

At a meeting of the Faraday Society on December 13, Professor F. O. Rankine delivered an address on "The Structure of Gaseous Molecules."

The Anglo-Batavian Society has proposed an extension of the scheme for the interchange of lectures between England and Holland and has suggested a course of eight lectures from the British side this session. The University of London has nominated Professor F. G. Donnan and Dr. J. F. Thorpe as lecturers in chemistry.

Joseph E. Goodrich, head of the agricultural department of the Loomis Institute, Windsor, Conn., died on December 21 at the age of forty years.

Mr. James Robert Appleyard, of the Royal Technical Institute, died on November 26, in Manchester, England, at the age of fifty-two years.

Wallace Lee has been appointed chief geologist to the Government of Siam. For the present his address is in care of the Commissioner General, Royal Railroad Department, Bangkok, Siam.

The directors of the Fenger Memorial Fund have set aside $500 for medical investigation. The work should have a clinical bearing and if possible it should be carried out in an institution that will furnish facilities and ordinary supplies free of cost. Applications with full particulars should be sent to L. Hektoen, 637 S. Wood Street, Chicago, before January 15, 1922.

Stanley Field, president of the Field Museum, Chicago, and nephew of Marshall Field, has contributed $265,000 to the museum. Captain Marshall Field has pledged $50,000 a year for five years; Charles R. Crane has given $30,000 and Arthur B. Jones $25,000.

THE seventeenth annual New England Intercollegiate Geologic Excursion was held October 15 at Attleboro, Massachusetts, under the leadership of Professor J. B. Woodworth of Harvard University. Forty-eight persons representing thirteen institutions were present. The institutions represented were as follows: Associated Petroleum Engineers, Brown University, Colby College, College of Education, Providence, Harvard University, Massachusetts Agricultural College, Mount Holyoke College, Tufts College, University of Vermont, University of Washington, United States Geological Survey, Wesleyan University, and Yale University. The group visited the exposures of Dighton conglomerate in the vicinity, of Attleboro, the Wamsuuta series consisting of red shales, felsites and diabases in South Attleboro, the Cambrian outcrops at Hoppin Hill, the shale series of the Coal Measures near the station at Plainville containing fossil plants and amphibian footprints, and other minor localities in the vicinity of Red Rock Hill and Oldtown. Plans were discussed for the eighteenth excursion which will be held in the vicinity either of Amherst or Worchester, Massachusetts.

WE learn from the *Journal* of the American Medical Association that the board of directors of the Gorgas Memorial Institute at the national headquarters in Washington has elected the following officers: Dr. William C. Braisted, president; Dr. Franklin Martin, vice-president; Dr. Arthur P. Robbins, Burlington, Iowa, executive secretary, and Mr. Edward J. Stellwagen, president of the Union Trust Company, Washington, treasurer. The purpose of the organization of an executive committee is to further a movement to introduce the sanitary methods devised by the late Surgeon-General Gorgas in all the civilized countries of the world. Word was recently received by the institute that Dr. Richard P. Strong, dean of the department of tropical medicine of Harvard University and former director of the biologic laboratory at Manila has accepted the post of scientific director of the Gorgas Memorial Institute of Tropical and Preventive Medicine to be built at Panama City on a site presented to the United States by Dr. Belisario Porras, president of the Republic of Panama. The presentation of the site was made recently in Philadelphia by José Lefevre, chargé d'affaires of Panama at Washington.

DR. CHARLES H. GILBERT, of the Bureau of Fisheries, and Field Assistant Henry O'Malley have returned from an extensive trip to Alaska, which was devoted to a study of the runs of salmon in the southeastern and central districts. Special attention was given to the salmon of Kodiak Island, where a rack had been constructed in Karluk River early in the season and the counting of red salmon ascending the stream was being carried on. It is reported that up to September 17, the total escapement of red salmon up the river was 1,322,000. Dr. Gilbert advises that the investigations in the Karluk region were most interesting and profitable. Every spawning stream tributary to Karluk Lake was examined.

EDUCATIONAL NOTES AND NEWS

THE American Association of University Professors meet at Pittsburgh on December 29 and 30 in association with the national societies devoted to the economic and social sciences.

DR. THEODORE LYMAN, director of the Jefferson Physical Laboratory of Harvard University and professor of physics since 1913, has been made Hollis professor of mathematics and natural philosophy. He is the ninth incumbent of this foundation, which was established by Thomas Hollis in 1727. Lyman's three immediate predecessors were Joseph Lovering, 1838–1888, and Lyman's teachers and friends, B. O. Pierce, 1888–1914, and Wallace C. Sabine, 1914–1919.

PROFESSOR HAROLD J. LOCKWOOD has been appointed professor of electrical engineering in the Thayer School of Engineering of Dartmouth College, to fill the vacancy caused by the resignation of Professor F. E. Austin.

Dr. Sydney Robothan Miller, associate professor of clinical medicine in the Johns Hopkins Medical School and president of the American Congress of Internal Medicine, has joined the staff of the University of Maryland School of Medicine.

Dr. W. Magner has accepted the position of director of the pathological department of the University of Toronto. He was formerly lecturer on pathology in University College, Cork.

DISCUSSION AND CORRESPONDENCE

THE ACQUISITIVE INSTINCT IN CHILDREN AS AN EDUCATIONAL STIMULUS

The educational value of the collections of various objects which children form has not received the universal recognition which it so well merits. The tendency to form collections of such objects as stamps, coins, post cards and bird's eggs has as its basis the instinct of acquisition. A child of two years hoards bits of cloth, clothes pins, and buttons without knowing why he does it. The object appeals to the child's senses, that is, the perception of the object stimulates his instinctive desire for possession.

Sometimes an epidemic of collecting will arise in a neighborhood as occurred in a suburb of Chicago, a few years ago, when most boys between the ages of eight and fourteen collected the pictures of baseball players coming with certain brands of tobacco. Boys collected the pictures because they saw others doing it, and because of that instinctive craving for things which please the senses. Here rivalry appeared. Boys vied with each other to see who could get the greatest number of pictures, and a value was placed upon them far in excess of their intrinsic worth.

The desire to collect without a definite purpose other than to see how many objects can be brought together continues into adolescence. At the age of twelve or thirteen, however, collections often assume an emotional character as those made up of souvenir spoons, theater ticket stubs, or later dance programs.

Up to this stage the instincts of acquisition, imitation, and emulation have furnished the stimulus for the collective mania, and even in collections of natural objects, reasoning has not played a basal part. Judgments were formed as to relative value, methods of acquisition, and arrangement of the objects, but as yet the purpose of collecting for systematic arrangement and study has not appeared.

Consider now the case of the stamp collector who has outgrown the desire for mere numbers. He considers methods of arrangment other than size or color, considering country and time of greater moment. He associates designs with historical events, and the portraits with national heroes. He notices the evolution of symbols and designs appearing on succeeding issues of stamps, as well as the progress made in printing and engraving from the earlier to the more modern representatives. Here is being developed the "scientific attitude of the mind," the expression of that desire to classify, arrange, and correlate fact. The comparing of concepts, of memory images, the formation of judgments, and reasoning enter into the mental process, while instinct is eclipsed by thought. Such a collection will furnish many lessons in reasoning; for in solving the problems arising in classification the habit of consistent thinking is materially aided.

Collections of natural objects as butterflies, shells, and leaves have an especially favorable influence upon the thought habit, but only if the desire to arrange and study systematically is present. The classification problems met with are so diverse and require such varied methods of approach that the training received in meeting them necessitates intense thought and a strong purpose.

It should be remembered, therefore, that a child's mania for collecting is the normal expression of an instinct; that this instinct can be diverted into emotional or intellectual channels; that when diverted intelligently it may be a great factor in the formation of the thought habit, the great purpose in any education. It seems well worth while to con-

sider methods by which the acquisitive instinct in children may be diverted by encouragement and suggestion so as to prove the stimulus for the higher forms of intellect.

WILLIAM DRUMM JOHNSTON, JR.
WALKER MUSEUM, UNIVERSITY OF CHICAGO

LINKAGE IN POULTRY

Two genes each of which is sex-linked must obviously be completely linked in the gametogenesis of the sex which is heterozygous for the sex gene. On Morgan's theory of inheritance they should also be partially linked in the homozygous sex, as in the female of *Drosophila*. I therefore decided to test for linkage between two well-known sex-linked genes of poultry, namely B, whose presence causes barring of melanic feathers, and S, which by inhibiting yellow pigmentation, converts "gold" into "silver" hackle feathers. A Brown Leghorn cock of composition bs/bs was therefore mated to Barred Plymouth Rock hens of composition BS. Their male children were of composition BS/bs. These were mated to bs Brown Leghorn hens, and have so far produced:

30 Barred silver BS/bs ♂ and BS ♀
17 Unbarred silver bS/bs ♂ and bS ♀
10 Barred gold Bs/bs ♂ and Bs ♀
21 Unbarred gold bs/bs ♂ and bs ♀

This corresponds to a series of spermatozoa 30 BS, 17 bS, 10 Bs, 21 bs, or 27 cross-overs out of 78. The cross-over value is therefore 34.6 per cent. with a probable error of 3.6 per cent., that is to say there is undoubtedly linkage. The numbers of barred and unbarred are practically equal, but there is a 50 per cent. excess of silver over gold, perhaps due to selective mortality.

The experiment is being continued, and it is hoped next year to obtain repulsion as well as coupling. If Pearl is correct in his view that one of the genes for high egg-laying is carried in the sex-chromosome, the economic importance of mapping it is considerable. For example if the locus of the egg-laying gene L_2 lies between those of B and S, then if B and S have been transferred together from a race of high-laying power to one of low-laying power, we shall know without further testing that, except in the rare cases of double crossing-over, L_2 has been transferred with them.

J. B. S. HALDANE
NEW COLLEGE,
OXFORD, ENGLAND

THE ZOOLOGICAL RECORD

The Zoological Record, which was founded in 1864 by English zoologists, has been issued regularly ever since and contains each year a complete bibliography of all publications connected with zoology. It is now the sole work of the kind, and is invaluable to all workers in every branch of zoology.

Previous to 1914 *The Zoological Record* formed part of the "International Catalogue of Scientific Literature," and was issued under the joint responsibility of the Royal Society and the Zoological Society. As the Royal Society found itself unable to proceed with the volumes of the "International Catalogue" after the issue for 1914, the Zoological Society has undertaken to prepare and issue the volumes for 1915–1920 inclusive at its sole financial risk.

It is the wish of the record committee of the Zoological Society to continue the publication of this most useful work, but it is obvious that they can not expect the Society to undertake the heavy financial liability involved in publication unless they receive reasonable support from working zoologists both at home and abroad.

I hope, therefore, that all working zoologists who agree with me that the suspension of the publication of the *Record* would have a most disastrous effect on the progress of zoology, will either subscribe themselves or will urge the librarians of the institutions with which they are connected to do so.

A prospectus and form of subscription either for the whole or separate divisions of the *Record* can be had on application to the Zoological Society.

W. L. SCLATER,
Editor
ZOOLOGICAL SOCIETY OF LONDON,
LONDON, N. W. 8

METEOROLOGISCHE ZEITSCHRIFT

IN a letter received from Professor V. Conrad, the recently elected secretary of the

Austrian Meteorological Society, he expresses the fear that the *Meteorologische Zeitschrift* may cease publication for want of funds. This would be a deplorable circumstance and a distinct loss to meteorology and science. He asks for subscriptions, the price being only $3.20 U. S. currency per year. It is hoped that this note may secure not only renewals, temporarily dropped during the war, but also new subscriptions, so that this valuable periodical may be saved from extinction.

Otto Klotz

Dominion Observatory,
December 6

SCIENTIFIC BOOKS

RECENT ADVANCES IN PALEOPATHOLOGY

An important contribution to the study of the origin and evolution of diseased conditions is contained in the recent volume by Dr. John M. Clarke[1] whose previous studies on this subject have enriched the literature of paleopathology.[2] He has, in the present essay, given a popularized account of his accurate paleontological studies, dealing with the nature of disease and the geological indications of its evolution. He calls attention specifically to the fact that there has been an evolution of disease similar to the evolution of organic forms. Certainly the evidence points to a progressive increase in pathological conditions throughout the geological ages.

Dr. Clarke's evidences are all selected from the field of invertebrate fossils in which his wide acquaintance with invertebrate paleontology and stratigraphy gives his opinion the greater weight. Only a specialist in this field would be able to discriminate benign pathological conditions from those of accidental post-fossilization erosions.

The author has a deeper purpose in view than merely contributing to the subject of paleopathology and his essay is a philosophical study of the nature of symbiotic and parasitic conditions of the ancient Paleozoic world.

Ths subject has been further enriched by the appearance of another volume dealing with the evidence of disease during a more recent period of the world's history.[3] This volume was prepared under the supervision of Lady Alice Ruffer of Ramleh, Egypt, as a memorial to her husband who lost his life in the recent war. The volume consists of nineteen essays which had been previously published in various journals, chiefly the *Journal of Pathology and Bacteriology.* These deal with detailed accounts of Sir Ruffer's studies on ancient Egyptian mummies; one paper relating to a condition of spondylitis deformans in a crocodile from the Miocene of Egypt.

These reprinted essays are accompanied by a brief biographical sketch and a list of Ruffer's writings.

Ancient Peru has contributed greatly to our knowledge of paleopathology, and the civilizations of the Incas and their predecessors have a diligent student in Edmundo Escomel,[4] a practising physician in Arequipa, Peru. His most recent contributions deal with discussions of the ancient surgical art of Peru; the instruments and results obtained, seen especially well in the numerous trephined skulls of the ancient Peruvian burials.

Roy L. Moodie

University of Illinois,
Chicago

SPECIAL ARTICLES

A SIMPLE METHOD OF OBTAINING PREMATURE EGGS FROM BIRDS

In connection with studies on the relation of the endocrine glands to sex and reproduc-

1 "Organic Dependence and Disease: Their Origin and Significance," Yale University Press, October, 1921, pp. 1–113; 105 figures.

2 "The Beginnings of Dependent Life," Fourth Annual Report, State Museum of New York, 1908, pp. 1–28, 13 plates and text-figures.

3 Sir Marc Armand Ruffer, "Studies in the Palaeopathology of Egypt," University of Chicago Press, October, 1921, pp. i–xx and 1–371; illustrated by 71 plates.

4 Dr. Edmundo Escomel, "Ciencia y arte en le prehistoria peruana," printed privately, Lima, Peru.

tion it was observed some months ago that injections of therapeutic doses of the active principle of the posterior lobe of the pituitary body sometimes causes a premature expulsion of the bird's egg from the oviduct. Soon afterward it was easily established that a somewhat larger dosage could be relied upon to cause an immediate expulsion of the egg from any part of the oviduct. Doubtless this action might have been anticipated from the well-known action of this secretion on the uterine muscle of mammals. The immature or oviducal egg can be utilized to much advantage in the investigation of several kinds of biological and chemical problems but the impracticability of obtaining such eggs—except through the often uncertain, ever expensive and self-limiting process of killing the mother bird—has hitherto handicapped such studies. It therefore seems worth while to describe this simple and useful method.

A full understanding of the method and its limitations involves the following facts concerning the premature egg: The bird's egg requires between 1 and 2 days to pass from the ovary to the exterior. In pigeons this period of passage down the oviduct is a little more than 40 hours. When the ovarian egg is laid it has therefore already undergone development during this number of hours and has had various accessory parts (albumen, shell-membranes, shell) added to it. The first 10 to 15 hours of this period involve the formation of albumen, while the shell is continually formed during the last 25 to 30 hours. The middle and lower portions of the oviduct are more highly muscular in structure than is the extreme upper portion (infundibulum, funnel) into which the egg first passes from the ovary. The movements which propel the egg along the oviduct are involuntary in origin; in the final muscular act of egg-expulsion voluntary action is also involved. In the dove or pigeon the egg is easily and positively palpable 30 hours before the normal time of laying.

The effectiveness of the method is sufficiently indicated in the table which has been constructed from the last series of injections made by us. It will be observed that, with few exceptions, the eggs were laid within 6½ to 25 minutes following the injection. They were laid at stages of immaturity varying from 4 to 26 hours. Four cases required a repetition of the injection. The egg sought at the 37-hour stage (No. 8) was not forced backward but forward into the body cavity—a fact later verified by abdominal operation. A 34-hour stage (No. 11) was, however, forced neither forward nor backward by a dosage one-half of that used in the other tests. In the case of one quite wild common pigeon (No. 14), injected late at night, three injections failed to cause the immediate extrusion of the egg, though they quickly forced the egg down to the extreme posterior part of the oviduct. The time limits involved in this case are uncertain. Egg No. 6 was laid without shell but with the membrane. Several eggs had very little shell while those taken only 4 to 10 hours before the normal period of laying were fairly provided with shell and were capable of incubation in the normal manner. The injections are nearly as effective in the common fowl, though in this case it is not possible to know the exact number of hours of immaturity of the egg thus secured.

The injections are made hypodermically (No. 1) or better intramuscularly into the broad muscles of the breast. Pituitrin of Parke, Davis and Co. was used in the injections cited in the table. It is unnecessary to use the preparation designed for use in obstetrics (used here in Nos. 9, 10, 11, 15, 16, 17) since the difficulty of infecting birds makes the use of pituitrin (oral) practicable. The size of the effective dose depends largely upon the age of the preparation. One preparation evidently made six months later than another was found to be twice as active as the older preparation. The dosage for the weaker preparation, which is perhaps near the average age of preparations on the market, was found (it was used in data of table) to be about 0.133 c.c. per kilo body weight. This dosage is about 4 times that used for

a limited period by us in a current study of the possible rôle of pituitary deficiency in reproductive disorders in birds. Even this smaller dosage not infrequently effected the prompt delivery of an egg. When injected at or near the hour of release of an egg from the ovary this same smaller dosage also sometimes prevents normal ovulation in the pigeon.

Experience has shown that an egg which has very recently entered the oviduct from the ovary can not be secured by this method. Injections rightly timed for this purpose result in the equivalent of an anti-peristalsis of the oviduct (ovum into body cavity); in the pigeon, however, it is easy to obtain prematurely eggs of somewhat more than 30 of the total 40 hours of oviducal development. As carried out by us the wildness of the bird is a factor in the interval of time from injection to laying. This results doubtless from the fact that, when kept close at hand for exact time records, the voluntary part of the act of expulsion is delayed or inhibited in the untamed birds.

It is evident that by this means eggs of various stages of immaturity—including successive eggs from the same parent—are made easily available for studies on the earlier stages of embryonic development; for experimental studies on these most modifiable stages; for chemical studies on various parts of the egg with less than the usual opportunities for change and admixture; and for isolating the functions of the various parts of the bird's oviduct. It is probable also that under certain conditions or limitations this reaction of the dove's oviduct—active and *in situ*—would be useful as a means of standardizing solutions of the active principle of the pituitary gland. Incidentally, it may be added that it has already been found practicable in this laboratory to utilize such prematurely laid eggs to make a crucial test of Stockard's[1] important suggestions on the cause of twinning and double-monster formation as these occur in birds.

[1] Stockard, C. R., *Amer. Jour. Anat.*, 1921, XXVIII., 115.

TABLE I

Data for One Series of Pituitrin Injections

Kind of Bird	No.	Dosage (in Thousandths of 1 c.c.)	Interval, Injection to Laying (Minutes)	No. of Hours Prematurely Laid
Ring-dove	1	22	25	4
	2	20	13	16
	3	22	8	16
	4	22	8	10
	5	22	14	10
	6	22	12	26
	7	22[1]	13	21
	8	22	Into b.c.	(37)
	9	28[2]	8	5
	10	20	6½	5
	11	10	Not laid	(34)
Common pigeon	12	44	13	18
	13	44	19	5
	14	44[1]	Some hrs.	+5
	15	44	22	5
Common fowl	16	264	(45)	?4
	17	2201	(33)	?4

[2] Injection repeated one or more times.

OSCAR RIDDLE

THE DISCOVERY OF OLENELLUS FAUNA IN SOUTHEASTERN BRITISH COLUMBIA[1]

IN the spring of this year, Col. C. H. Pollen, of Cranbrook, British Columbia, forwarded to the University at Vancouver, specimens of chocolate-brown shales showing imprints of lower Cambrian trilobites.

In May, the writer visited the locality for the Geological Survey of Canada, made further collections and studied the stratigraphy over a wide area.

The fossils collected were submitted to Dr. Charles D. Walcott, secretary of the Smithsonian Institution, who identified the following genera and species:

Callavia, cf. *nevadensis* Walcott,
Wanneria n. sp. ?,
Mesonacis gilberti Meek,
Wanneria, cf. *walcottanus* (Wanner),
Olenellus, cf. *fremonti* Walcott,
Prototypus senectus Billings,

Dr. Walcott states concerning the collection:

[1] Published with the permission of the Director, Geological Survey, Ottawa, Canada.

This fauna belongs to the upper portion of the Lower Cambrian, and it is essentially the same as that found above the tunnel at Mt. Stephen, B. C., and also found more or less all along the Cordilleran system down into southern Nevada.

The stratigraphy of the section is as follows:

Lower Cambrian	Chocolate-brown shales —*olenellus fauna*...	50 + feet
	fine-grained quartz conglomerate	300 + feet
	coarse conglomerate...	6 feet
	disconformity	
Precambrian Beltian	purple and green mud cracked siliceous metargillites (Siyeh)..	300 ± feet
	Purcell lava—amygdaloidal basalt.......	100 feet
	purple and green mud cracked siliceous metargillite and siliceous limestones......	1,000 + feet
	(Siyeh formation)	

In the Cranbrook area the characteristics of the disconformity between the Cambrian and Precambrian are:

1. The thickness of the sediments between the Purcell lava and the basal conglomerate of the Lower Cambrian varies from a few feet to three hundred feet, showing evidence of an unconformity.

2. The upper surface of the Precambrian does not show any evidence of weathering before the deposition of the Lower Cambrian.

3. The Precambrian and Cambrian strata correspond in dip and strike. At no place were discordant relationships observed.

4. The metargillites of the Precambrian are more highly metamorphosed than those of the Cambrian.

5. The contrast in lithology between the Precambrian and Cambrian formations is very marked. Mud cracked and ripple marked purple and green metargillites are characteristic of the Precambrian while the Lower Cambrian rocks are white quartzose conglomerates succeeded by grey and chocolate-brown shales.

6. The basal conglomerates of the Cambrian contain rounded fragments of the underlying siliceous argillites.

A full detailed statement concerning the stratigraphical relationships of the Precambrian and the Cambrian over a wide area is now in course of preparation to be published by the Geological Survey of Canada.

STUART J. SCHOFIELD
UNIVERSITY OF BRITISH COLUMBIA,
VANCOUVER

HOWARDULA BENIGNA; A NEMA PARASITE OF THE CUCUMBER-BEETLE

Howardula[1] Cobb. Characters of *Aphelenchus* Bastian, 1865, but without œsophageal bulb and with a non-bulbous onchium and much reflexed ovary. "Female" finally a flaccid, cylindroid sack, without distinct alimentary canal, and otherwise much deteriorated. Syngonic; male unknown. *Howardula* may be related to *Bradynema* zur Strassen, 1892, but the latter has no onchium and even lacks a mouth opening.

$$\frac{1.1 \quad (?)5. \quad (?) \quad {}^{95}\text{‘}98. \quad (?)99.}{2.5 \quad 4.0 \quad 4.7 \quad 4.1 \quad 1.9}\ 3.5\text{–}5.\ \mathrm{mm}$$

Howardula benigna Cobb. Anus none or vestigial; vulva sometimes terminal; uterus nearly filling the body-cavity, posteriorly packed with larvæ and anteriorly with segmenting eggs, near the head in the vicinity of the small spermathecum narrowed and reflexed to the middle of the body, whence the narrow ovary turns forward and ends blind near the lead; onchium usually very obscure but the minute mouth opening still persisting. Inert, viviparous, usually all of the same stage of development in any individual host-insect, each when mature containing about two thousand embryos and segmenting eggs; the larvæ, apparently always all of one kind, sometimes ten to twenty thousand of them, proceeding from the mother nemas into the body-cavity, and into the sexual ap-

[1] Named for my distinguished friend Dr. L. O. Howard, chief of the U. S. Bureau of Entomology, president and past permanent secretary of the American Association for the Advancement of Science.

paratus, of the host, and so becoming deposited with the eggs of the latter.

FIG. 1. Shows relative volume of beetle and parasites. The line XY shows the actual length of the beetle.

The newborn larvæ measure as follows:

$$\frac{3.4 \quad (?)12. \quad 28. \quad -91. \quad (?)94.8}{2.3 \quad 3.2 \quad 3.7 \quad 2.8 \quad 2.2}\ 0.54\text{ mm}$$

Anus none or vestigial; tail conoid, straight, broadly rounded or subtruncate at the terminus. After deposition along with the beetle eggs, the young nemas moult with little increase in size, some of them then boring their way into the body-cavity of even very young larvæ of both sexes of the beetle, sometimes to the number of thirty but more often five or six. The following are the dimensions and other details of these young but already spermatized individuals, as found both in the soil and in very young beetle-larvæ, which in the body-cavity of the host reach the above, seven to ten times longer, mature form:

$$\frac{2. \quad 16. \quad (?)24. \quad \overset{75}{-}95. \quad (?)\ 97.}{2. \quad 4. \quad 5. \quad 4. \quad 2.6}\ 0.5\text{ mm}$$

Habitat: Common in the body-cavity (abdomen, thorax and even head) of *Diabrotica vittata, trivittata,* and *12-punctata,* especially the former, infesting the two sexes about equally.

My attention was called to this nema by Mr. W. V. Balduf, Assistant Entomologist, Ohio Agricultural Experiment Station, Marietta, Ohio, where he discovered the larvæ in

FIG. 2. Cucumber-beetle egg and the charge of nemas deposited with it.

the course of experiments on *Diabrotica.* Owing to the economic aspect of the subject, beetles sent me by Mr. Balduf were exhibited, dissected, at the Washington Helminthological Society's meeting, March 17, 1921. Examination revealed the adult female form, which is so flaccid and otherwise deceptive as to cause it rather easily to be confused with the internal organs of the host by one not versed in both insect and nema anatomy.

Aided by Dr. F. H. Chittenden and colleagues of the Federal Bureau of Entomology, and by others, the geographical distribution of the nema was studied with results shown on the accompanying map, which indicates that the distribution in 1921 is probably nearly coextensive with that of the main hosts, *Diabrotica vittata* Fab. and *trivittata* Mann. The nematism is often high and affects on the average about 20 per cent. (0 per cent.—70 per cent.) of the insects. Beetles from a locality where they are not nematized are larger and more vigorous. Thus twenty-five

beetles from an uninfested lot were much larger and averaged seventy per cent. heavier than a similarly chosen twenty-five from a fifty per cent. nematized lot. Anatomical evidence shows the infested female beetles to be less fertile than the non-infested, doubt as to diminished fecundity vanishing where the female host harbors a dozen or more adult nemas. In such cases the mere relative volume of the parasites is convincing evidence of handicap. See Fig. 1. Mr. Balduf in a letter speaks of beetles, many of which "died of nemas." I have no rigid proof of such deaths, but believe them very probable and at times numerous.

FIG. 3. The map-figures give the percentage of beetles found infested by *Howardula*. The figures for different localities a few miles apart in any given region usually were in substantial agreement. Where the percentage of infestation was highest, the nematism was highest, and vice versa. The presence of the nema does not exclude other internal parasites, such as other insects and gregarines. About 1,500 *D. vittata* were examined. Below are addresses of those who kindly contributed insects for examination.

Balduf, W. V., Marietta, O.
Cobb, Dr. F., Ann Arbor, Mich.
Cobb, V., Whitman, Mass.
Chapin, E. A., Falls Church, Va.
Fenton, E. A., Ames, Iowa.
Flint, W. P., Urbana, Ill.
Gentner, L., Lansing, Mich.
Hall, Dr. M. C., Chevy Chase, Md.
Harned, R. W., Agr. College, Miss.
Haseman, L., Columbia, Mo.
High, M. M., Kingsville, Tex.
Kelsall, A., Annapolis Royal, N. S.
Raps, E. M., Oakton, Va.
Riley, Wm. A., St. Paul, Minn.
Ross, W. A., Vineland Sta., Ont.
Smith, C. E., Baton Rouge, La.
Thomas, W. A., Chadbourn, N. C.
Walters, M. J., New London, Ct.
Watson, J. R., Birmingham, Ala.

In none of the numerous lots of beetles examined was the rate of infestation by any other zoo-parasite as high as by *Howardula*, with the single exception of a forty-three per cent. dipterous infestation; but no note was made of degrees of phyto-infestation (cucumber-wilt organism, etc.).

As many as thirteen thousand nema larvæ, by count, have been removed from the body-cavity of a single *Diabrotica vittata*, and no doubt the number may go much higher. On several occasions twenty or more adult Howardulas have been taken from a single beetle. Theoretically these should produce some forty thousand larvæ or more. The older female

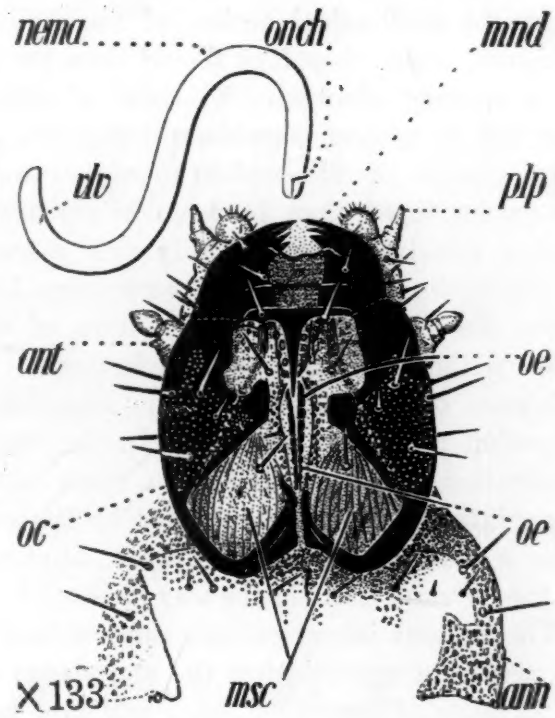

FIG. 4. Head of very young cucumber-beetle larva and of young *Howardula* at the time of its entrance. The mandibles of the grub, *mnd*, would seem to be impassable to the nema.

beetles, when nematized, deposit from a few to upwards of fifty of the nema larvæ with each egg. See Fig. 2. These soon mature on the eggs or in the soil (where they can live several weeks), moult, develop a more perfect spear, and by its aid begin to make their way into the body-cavity of the beetle grubs soon after the latter hatch out. That it is rather improbable the nemas enter the host by way of the mouth and alimentary canal is illustrated in Fig. 4. The active young beetle larvæ are armed with sharp-toothed, well developed mandibles. That the tender young nemas could pass so relatively small a throat and mouth, armed as the latter is, one hesitates to believe.

In plant-infesting triplonchs I have shown the development of the so-called salivary glands to be greatest in species noted for their efficiency in destroying the tissues of the host, and suggested that these glands aid in dissolving the host tissues and thus supplement the mechanical action of the spear or onchium, which therefore should then act also as a spewing channel. In light of this, it may not be without significance that the salivary glands of *Howardula benigna* appear better developed than in some of its nearest known relatives. Conceivably this secretion is also antiseptic. Nemas of very many kinds make their way through the tissues of their hosts without causing fatal infections. The existence of an antiseptic nema secretion or excretion might explain this. In the case of *Diabrotica,* there is no known trace left of the relatively large breach made by the parasite, a benignant result perhaps facilitated by the parasite itself in the way indicated.

The present investigations suggest how far we are from appreciating the abundance and importance of insect parasites and how backward in attempting their control. *Howardula* is, beyond any reasonable question, ages old, for on no other supposition can the remarkable relationship of host and parasite be explained. It is only one of a considerable number of parasites of the same destructive insect that have much to do with the welfare of the host. Intelligently increasing the incidence of the parasites decreases the ravages of the host. When we come to understand these relationships, these "balances" between host and parasite, doubtless we can do much toward inclining the "balance" in our favor. We hear more or less of organisms introduced to new areas without their enemies and parasites, and in consequence becoming frightful pests, and we have, very painfully and slowly it seems to some of us, learned that searching for and introducing these same enemies and parasites affords relief. Marked successes of this kind at least place it beyond doubt that this portion of the field of economic parasitology will be carefully explored. But there is another very important part of the field of which we hear little if anything, and that is the comprehension and watchful control of what may be termed indigenous or long-established "balances."

The cucumber-beetle affords good enough example of these latter to justify an appeal, on the basis of it, to economic biologists to scrutinize more carefully the ever changing "balances" between pests and their parasites and other enemies, *including pests of long standing,* with a view to keeping the "balance" always inclined in our favor. I believe any well trained, experienced and thoughtful biologist will agree that such a course is bound finally to result in notable economies. A case in point is the existence of localities, among those here tested, in which the total zoo-parasitic infestation of the beetles reached only about two per cent. At the same time not very far away there was a nema infestation exceeding fifty per cent. and a dipterous infestation exceeding forty per cent. The investigation showed that the transference by post of these two parasites from the highly infested areas to the low or non-infested areas was easily feasible at small cost. Posted in a ventilated box with a few cucurbit leaves the infested beetles undergo a two to four days' journey; set loose at night they survive without apparent injury.

N. A. Cobb
United States Department of Agriculture

SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.

New York City: Grand Central Terminal

Entered in the post-office at Lancaster, Pa., as second-class matter, under the act of March 3, 1879